TARDEC Hybrid Electric Program Last Decade

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
17 NOV 2010	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
TARDEC Hybrid Electric Program Last Decade	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Gus Khalil	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA	**21346RC**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA	**TACOM/TARDEC**
	11. SPONSOR/MONITOR'S REPORT NUMBER(S) **21346RC**

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**14**	

Army Hybrid Electric Vehicles

FY 98 99 00 01 02 03 04 05 06 07 08 09

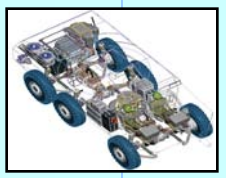
Combat Vehicle Demos


M113 HE


Lancer


AHED 8x8

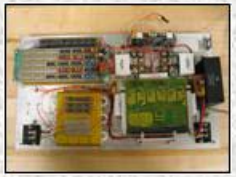

Pegasus

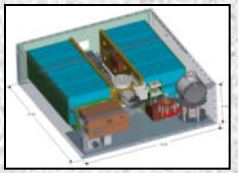

FCS

Technology Base


Traction Motors


Energy Storage

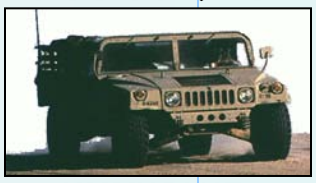

SiC Inverters/ Converters


Pulse Technology


Alternative Architectures


Modeling and Simulation

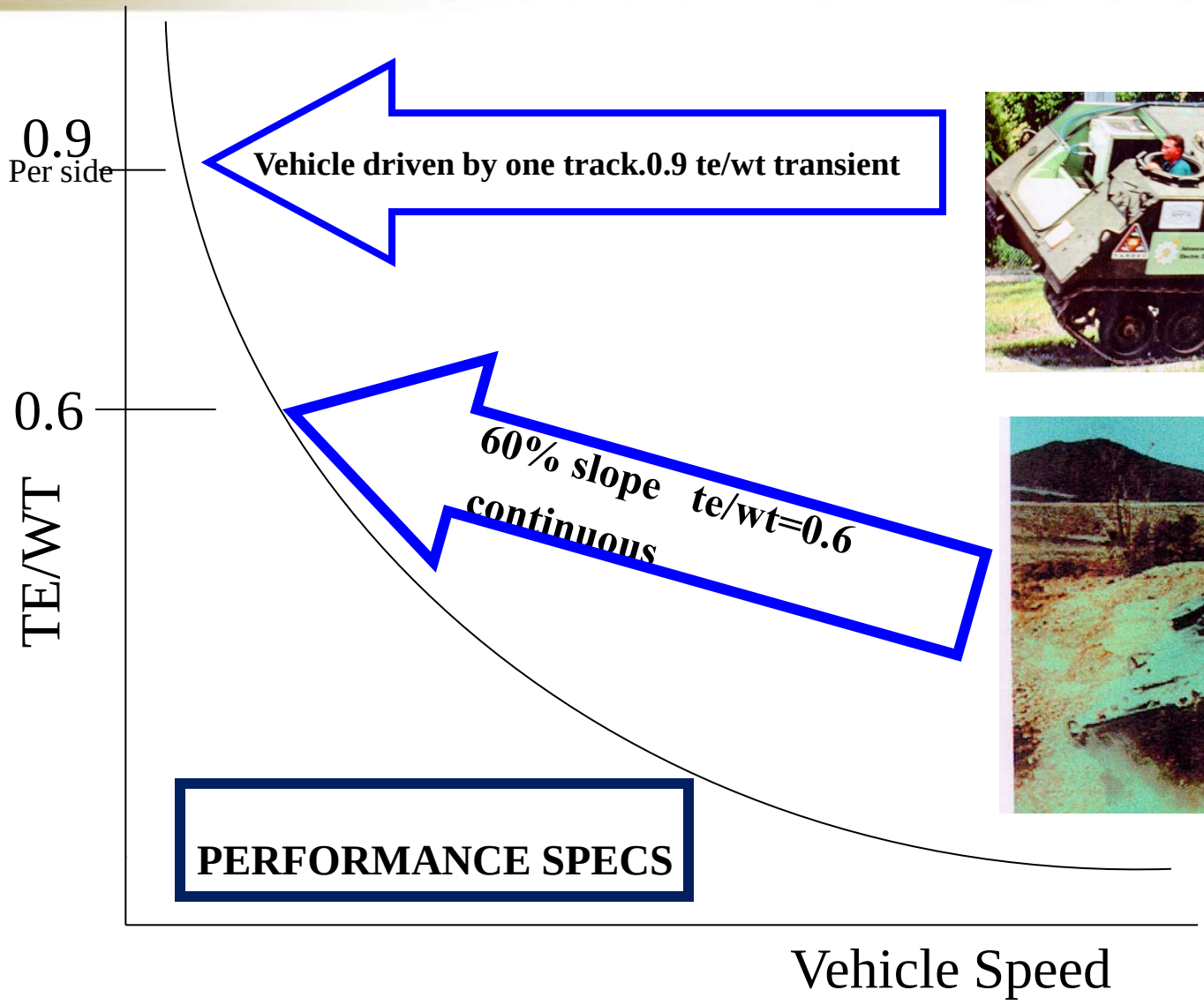
Tactical Vehicles


HMMWV HE


FMTV HE


RSTV


FTTS



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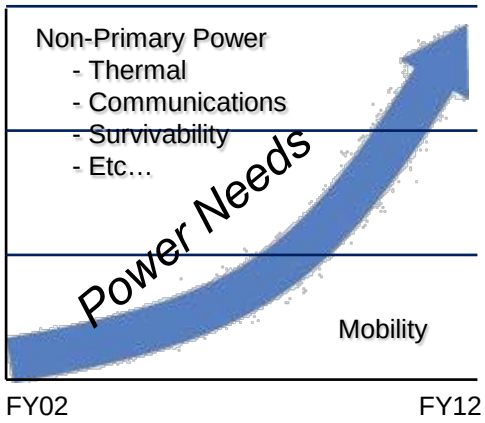
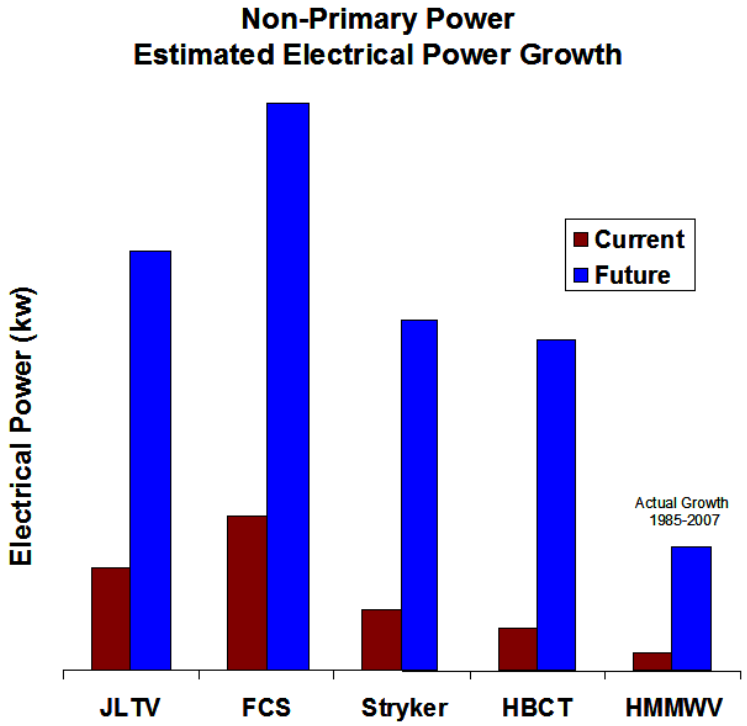
Ground Vehicle Power Needs





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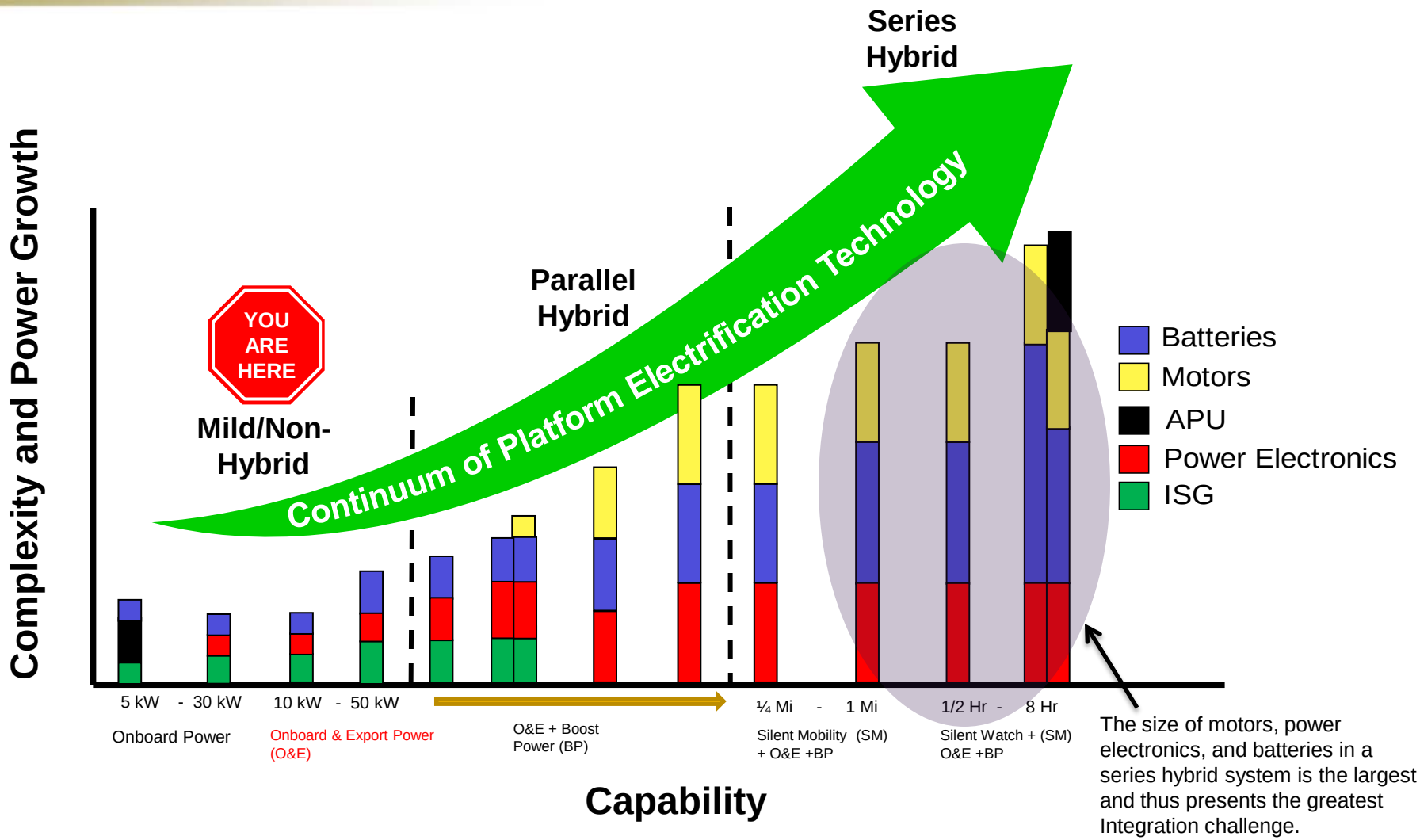
Platform Electrification Technologies



Hybrid Electric Drive Configurations Can Vary to Fulfill Desired Capability

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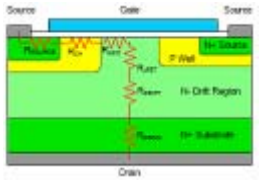
Hybrid Vehicle Challenges

Unprecedented use of emerging technologies never proven in battle field scenarios

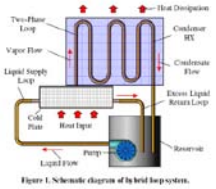
- System integration and packaging
  - Power densities of components
    - Motors, generators, energy storage
    - Power electronics
- Thermal management
  - Low operating temperature
    - Large space claims
    - High power demand from the engine/generator
- Silent Watch requirement
  - Energy storage shortfalls
  - Control strategy and limited power budget
- Onboard Exportable power
  - Clean power for Tactical Operating Centers (TOC)
  - Power supply from mobile platforms for other applications

High Power density motor

SiC MOSFET



Phase change cooling

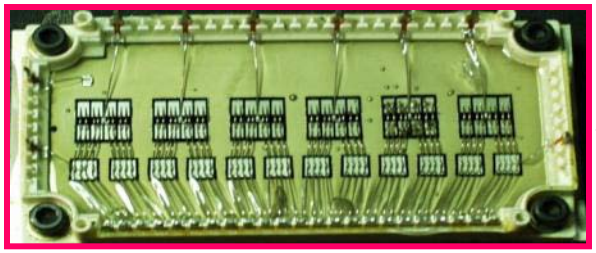


Li-Ion Battery Pack

Tactical Operation Center (TOC)

Hybrid Electric Component Program

- Traction Motors
- Energy Storage
  Li-Ion
- Power Electronics/cooling
- Vehicle tests:
  - ATC
  - AAEF



Thermal Management

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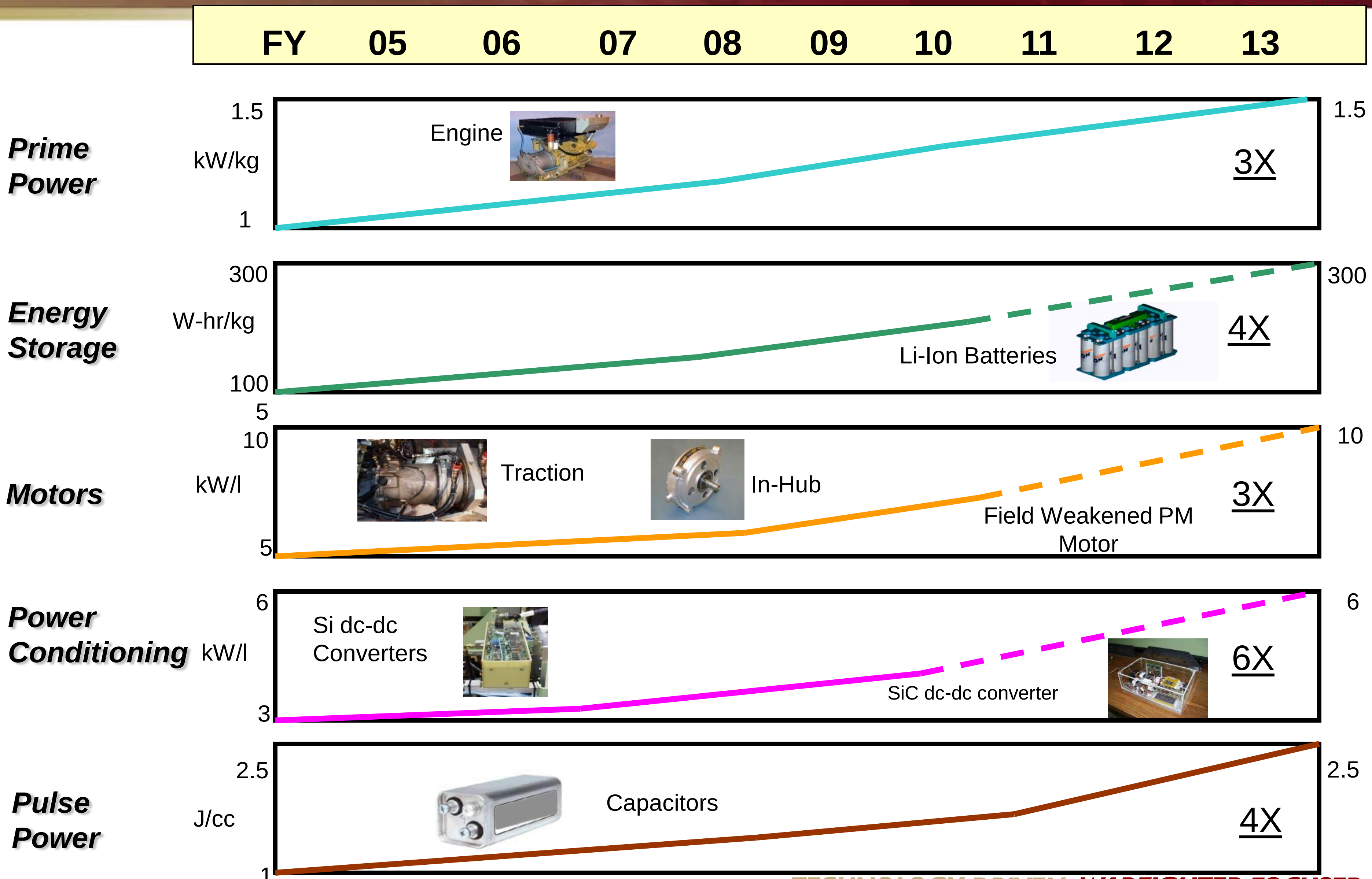
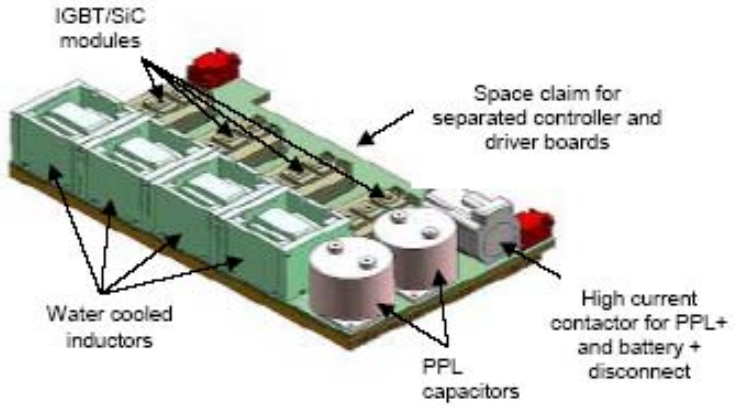
Technology Goals



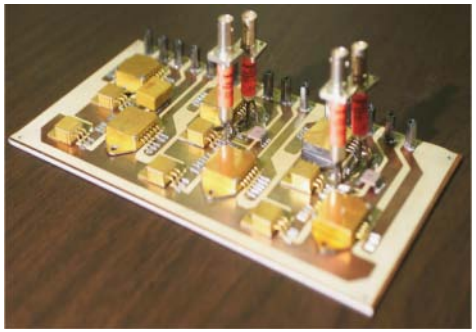
Power Electronics

- Thrust is SiC to overcome:
  - Thermal issues
  - Efficiency
  - Low frequency requiring large capacitors
  - Low power density

Approach: Develop power devices using SiC diodes as an interim step
Develop All SiC motor drives and DC-DC converters as the device technology matures



100 kW Si/Si-C hybrid DC-DC converter



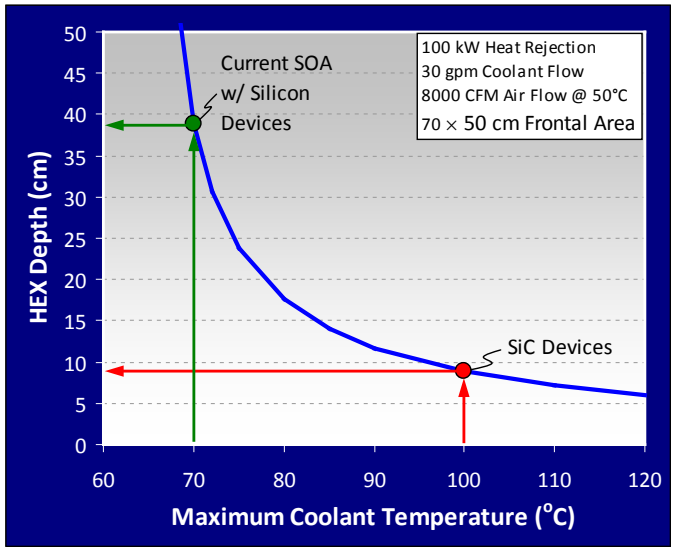
All-Si-C motor-drive inverter

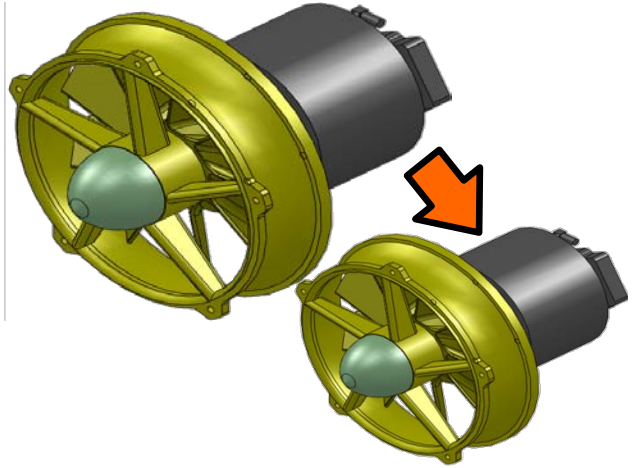
SiC PiN Diode Module

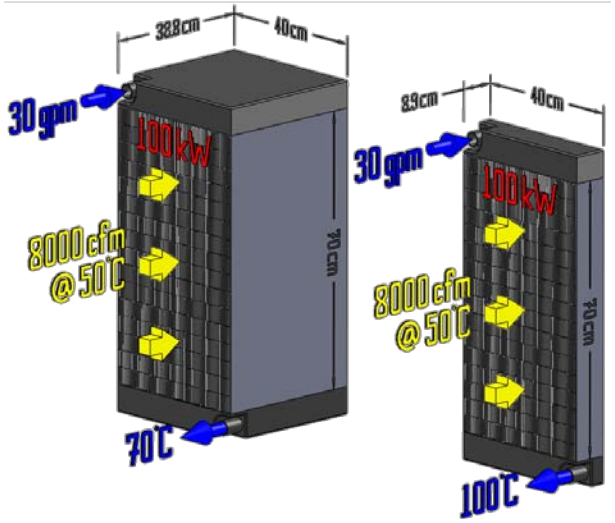
Improved Power Electronics Attributes

- Si based power electronics require coolant inlet Temperature not to exceed 70°C resulting in large cooling system size

- SiC can operate at much higher temperatures ≥ 100°C thus reducing the size of The cooling system by half







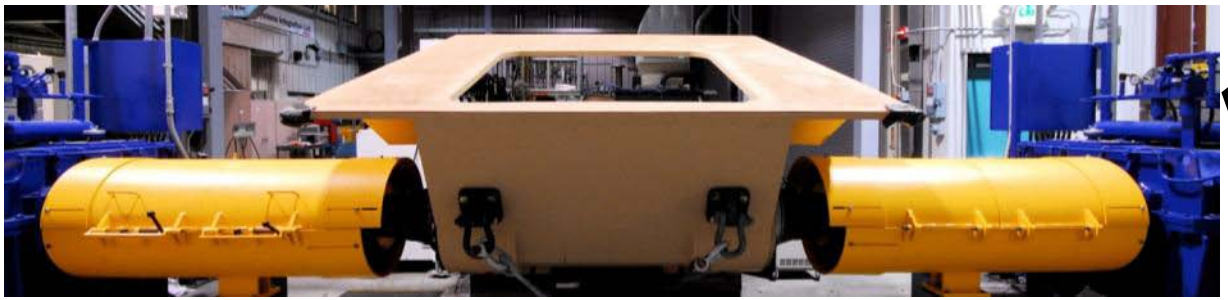
Advanced SiC Components will Reduce the Power Electronics Cooling Burden

Power and Energy SIL

The SIL provides capability to accelerate the integration and maturation of critical FCS MGV system technologies in order to meet FCS Performance within the weight and volume constraints

System Integration

System integration into vehicle platform



HOTBUCK platform with FCS hardware

Hybrid Electric Vehicle Experimentation and Assessment (HEVEA)

Currently there are no industry or SAE standards for measuring the fuel economy of hybrid vehicles in cross country environments.

Objectives

- Develop HEV Test Operating Procedure (TOP) using accepted industry practices and DOE processes
- Determine the fuel economy benefits of hybrid electric vehicles using quantifiable test data
- Develop and Validate TARDEC M&S models

Testing

9 conventional and 7 hybrid electric vehicles are being tested

A. Conventional:
2 - HMMWVs,
2 -21/2T LMTVs
1 - 5T MTV
1 – FMTV CVT
2 - HEMTTS
1 – UV

B. Hybrid Electric:
1 – HMMWV
1 – RSTV
1 - UV
1 – UV
1 – AH/SS MSV
1 – FMTV
1 – HEMTT A3

HMMWV Series HE

RSTV Series HE

Parallel Hybrid MSV

2 Parallel hybrid UVs

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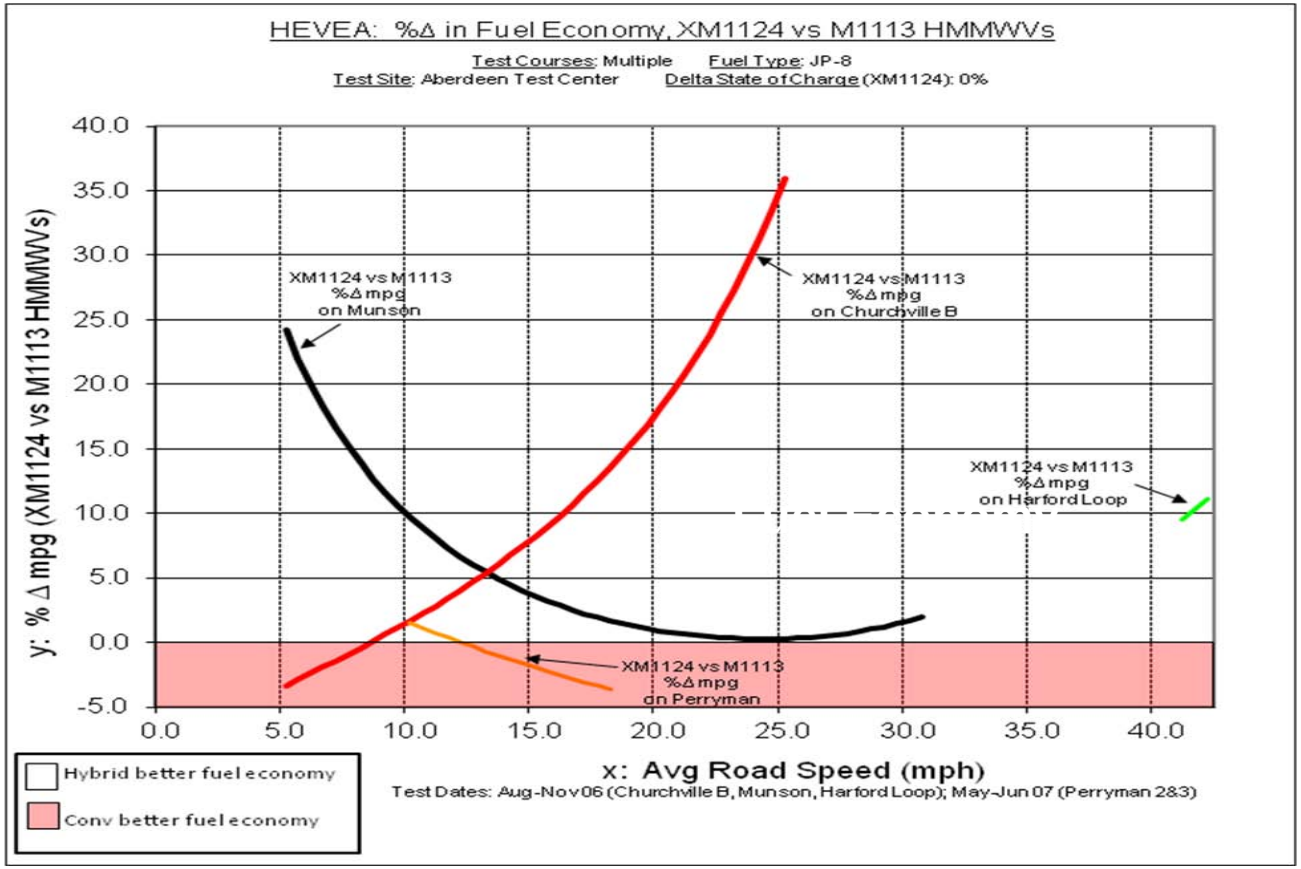
Improved Fuel Economy

Hybrid Electric Vehicle Experimentation and Assessment (HEVEA) Program



HMMWV Series HE

Hybrid Electric Drive HMMWVs demonstrated a 4.2 – 10.9% Fuel Economy Improvement over various military courses under HEVEA program.

HTUF DOD Tech Model

- Proven process to launch commercial production, focusing on user needs
- Over 80 national fleets, including DOD, involved in process
- Eight National Meetings of top truck OEMs, suppliers, fleets
- First 24 Pre-Production Trucks tested & fielded w/in 3 Years; million miles of experience; directly led to commercial production launch
- Military receiving first in-use hybrid field data from geographically dispersed nationwide deployment
- Six fleet Working Groups active, new Construction Equip Forum launching
- Three additional pilot deployments ready

HTUF Industry Contact Point for Dual-Use Heavy Hybrid Technologies

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